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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/646,612	08/22/2003	Kenneth S. Collins	6915 P04	8623

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EXAMINER	
LUK, OLIVIA T	
ART UNIT	PAPER NUMBER

2812

DATE MAILED: 03/16/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/646,612

Applicant(s)

COLLINS ET AL.

Examiner

Olivia T. Luk

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-87 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1,5-35,37-47,55-58,70-72,79,80,86 and 87 is/are rejected.
- 7) ☒ Claim(s) 2-4,36,48-54,59-69,73-78 and 81-85 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 5/28/04, 9/22/03. 11/16/03
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: ____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1, 5-10, 12-14, 30, 35, 45, 46, 55-58, 86 and 87 are rejected under 35

U.S.C. 102(b) as being anticipated by Chen et al. (6,139,697).

In re claims 1, Chen et al. discloses placing said workpiece 10 on a workpiece support 48 in a chamber 40 with said layer being facing relationship with a ceiling of said chamber, thereby defining a processing between said workpiece and said ceiling (col. 8, lines 43-45); introducing into said chamber a process gas comprising the species be implanted in said layer said workpiece (col. 8, lines 25-30); generating from said process gas a plasma by capacitively coupling RF source power across said workpiece support and said ceiling or said sidewall from an source power generator (col. 8, lines 17-24); applying an RF bias from an RF bias generator said workpiece support (col. 8, lines 15-20).

In re claim 5, Chen et al. discloses setting said bias a level corresponding to a desired depth in said layer which said element be implanted (col. 10, lines 26-34).

In re claim 6, Chen et al. discloses said layer comprises a semiconductor material, and said species to be implanted comprises a dopant impurity that promotes one of a p-type or n-type

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conductivity in said semiconductor material, and wherein said desired depth to which said element is to be implanted corresponds a desired p-n junction depth (col. 7, lines 20-35).

In re claim 7, Chen et al. discloses said gas comprises a chemical combination of said dopant impurity and another element (col. 8, lines 25-35).

In re claim 8, Chen et al. discloses the gas comprises a fluoride of said dopant impurity (col. 8, lines 25-35).

In re claim 9, Chen et al. discloses the gas comprises a hydride of said dopant impurity (col. 8, lines 25-35).

In re claim 10, Chen et al. discloses said gas further comprises co-implant ion bombardment element which removes from a top surface of said layer a material that tends accumulate during implantation said dopant impurity (col. 8, lines 25-35).

In re claim 12, Chen et al. discloses said layer comprises a dielectric thin film 12 wherein said species comprises a surface-enhancement which enhances characteristic of said dielectric layer upon implantation and substitution (col. 7, lines 25-35).

In re claim 13, Chen et al. discloses the characteristic is the electrical behavior of the dielectric thin film (col. 7, lines 45-50).

In re claim 14, Chen et al. discloses the dielectric thin film comprises an oxide of a semiconductor element, and the species comprises a non-oxygen element to be substituted for oxygen atoms in the dielectric thin film (col. 8, lines 25-35).

In re claim 30, Chen et al. discloses the process gas is one of (a) hydride of said dopant species or (b) fluoride said dopant species, and said ion bombardment element comprises one of:

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Helium, Hydrogen, a semiconductor element the type including Germanium, Carbon, a fluoride semiconductor element of fluorides of Silicon, Germanium, Carbon (col. 8, lines 25-42).

In re claim 35, Chen et al. discloses said semiconductor element comprises one silicon or germanium (col. 5, lines 37-50).

In re claims 45 and 46, Chen et al. discloses pulse modulating the RF bias and source power (col. 10, lines 30-34).

In re claim 55-58, Chen et al. discloses a bias frequency between 10kHz and 10MHz; 50kHz and 5MHz; between 100kHz and 3MHz; and about 2MHz to within about 5% (col. 9, lines 26-29).

In re claim 86, Chen et al. discloses the step of capacitively coupling RF source power said workpiece support **48** and said ceiling sidewall **40** from an RF source power generator **64** comprises applying RF power from said RF source power generator said ceiling or said sidewall while connecting workpiece support pedestal **78** to an RF return potential (col. 9, lines 14-45).

In re claim 87, Chen et al. discloses the step of capacitively coupling RF source power across said workpiece support **48** and said ceiling or said sidewall **40** from RF source power generator **64** comprises power from said RF power support pedestal **78** while connecting said ceiling or said sidewall to an RF potential (col. 9, lines 14-45).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (6,139,697) in view of Wu et al. (4,584,026).

In re claim 11, Chen et al. is applied supra, but fails to specifically disclose a pre-implant ion bombardment species creates damage in the semiconductor crystal. Wu et al. teaches that it is well known in the art to perform methods of amorphizing the surface of a silicon substrate by pre-implant ion bombardment (col. 3, lines 29-52). It would have been obvious to one having ordinary skill in the art to have performed a pre-implant ion bombardment in the invention of Chen et al. for amorphization of the substrate prior to annealing.

5. Claim 47 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (6,139,697).

In re claim 47, Chen et al. discloses the elements as claimed and teaches using a pulse RF bias power (col. 10, lines 31-34), but fails to specify the relation between the pulse modulating of the RF bias power and RF source power is one of (a) push-pull, (b) in-synchronism, (c) symmetrical, (d) non-symmetrical. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have maintained one of these relations between the

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RF bias power and RF source power since the pulse modulation must have been one of these relationships.

6. Claims 22-25 and 70-72 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (6,139,697) in view of Paton et al. (6,811,448 B1).

In re claims 22-25, and 70-72, Chen et al. is applied supra, but fails to teach pre-cleaning the wafer. Paton et al. teaches pre-cleaning a wafer prior to exposure to plasma (col. 4, lines 14-20). It would have been obvious to one having ordinary skill in the art at the time the invention was made to pre-clean the wafer prior to exposure to plasma, to eliminate any native oxide on the surface of the semiconductor (col. 4, lines 38-43).

7. Claims 26-29, 32-34, 37-44 and 79-80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (6,139,697) in view of Wolf (Silicon Processing for the VLSI Era; Vol. 1).

In re claims 26-29, 37-44, and 79-80, Chen et al. is applied supra, but fails to teach or reasonably suggest the plasma step followed by annealing to cause atoms of the species implanted to be substituted into atomic sites in a crystal lattice of the layer. Wolf teaches the plasma step followed by annealing to cause atoms of boron implanted to be substituted into atomic sites in a crystal lattice of the layer (page 305). It would have been obvious to one having ordinary skill in the art at the time the invention was made to have the plasma step followed by annealing to cause atoms of the species implanted to be substituted into atomic sites in a crystal lattice of the layer for regrowth enhancement.

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In re claims 32-34, Chen et al. is applied supra, but fails to teach or reasonably suggest the dopant impurity is boron, arsenic, or phosphorus. Wolf teaches the dopant impurity to be either boron, arsenic, or phosphorus. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used either boron, arsenic, or phosphorus as the dopant, since they promote regrowth of the amorphous layer (page 305).

8. Claims 15-21, 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (6,139,697) in view of Chung et al. (6,513,538).

In re claims 15-21, Chen et al. is applied supra, but fails to teach introducing a passivation process gas for forming a passivation layer with plasma. Chung et al. teaches introducing a passivation process gas for forming a passivation layer with plasma (col. 3, lines 55-65). It would have been obvious to one having ordinary skill in the art to have introduced a passivation process gas for forming a passivation layer with plasma for improved interface quality.

In re claim 31, Chen et al. is applied supra, but fails to teach a passivation layer-removing gas comprises NF_3 . Chung et al. teaches a passivation layer-removing gas comprises NF_3 (col. 4, lines 15-25). It would have been obvious to one having ordinary skill in the art at the time the invention was made to have taught a passivation layer-removing gas comprises NF_3 since NF_3 is known to remove the passivation layer before annealing of a substrate.

Allowable Subject Matter

9. Claims 2-4, 36, 48-54, 59-69, 73-78, 81-85 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

In re claims 2-4, 52-54 prior art of record fails to disclose or reasonably suggest a bias frequency that is sufficiently low for ions in a plasma sheath near the workpiece to attain an ion energy at least nearly equivalent to a peak-peak-voltage of the RF bias generator.

In re claim 36, prior art of record fails to teach the step of applying bias power comprises selecting a level of said bias power promotive of a sufficiently collisional plasma sheath over said workpiece to produce a significant fraction of ions impacting said layer at trajectories other than orthogonal to said layer whereby to implant ions in said horizontal and non-horizontal surfaces of said layer.

In re claims 48-51, prior art of record fails to teach a single burst of RF bias power.

In re claims 59-69, prior art of record fails to teach the species to be implanted comprises a first atomic element and the process gas has a second atomic element in chemical combination with the first atomic element.

In re claim 73, prior art of record fails to teach an optical metrology chamber for measuring ion implantation and adjusting the magnitude of the bias in accordance with the measurement.

In re claims 74-78, prior art of record fails to teach an ion beam implantation apparatus for implanting a second species in the layer of an opposite conductivity type.

In re claim 81, prior art of record fails to teach the photoresist strip chamber after the plasma step.

In re claim 82, prior art of record fails to provide a wet clean chamber after the plasma step.

In re claims 83-85, prior art of record fails to teach a second plasma immersion ion implantation reactor.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. References not applied are considered state of the art in the area of semiconductor manufacture.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Olivia T. Luk whose telephone number is 571-272-1676. The examiner can normally be reached on 8AM to 5PM Mon-Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt can be reached on 571-272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

OTL
February 25, 2005



MICHAEL LEBENTRITT
SUPERVISORY PATENT EXAMINER